## **APPENDIX A:** Hybrid System Model and Economic Summary Tables

This appendix contains the hybrid system model and economic summary tables used to develop the economic conclusions reached in this report.

## SAN CLEMENTE ISLAND HYBRID SYSTEM MODEL

## Maximum number of wind turbinee: 1

		dional antu-							salmal in deal										
		area only.							wind hybrid Single	Meximum								>	Original
			Diesel	Percent of		starts	Diesel	Adjusted Wind	Turbine Wind	Allowed Wind	Number of	Net	Diesel	Percent of	Litres of	etarte	Diesel	litree	Wind Speed
Date	Time (hr)	Demend (KW)	Rating (kW)	Rating Used	Diesel Consumed	counter	run time (houre)	Speed (m/s)	Power (kW)	Demand (kW)	Turbines	Demand (kW)	Rating (KW)	Rating Used	Diesel Consumed	counter	run time (hours)	saved	6.1 m/s
							, ,	, ,	, ,	,,		<b></b>	(,	****			()		
Average		869.7	1531.7		306.9			6.1	53.1	669.7	0.8	816.5	1448.9						8.119481
Standard D Maximum	eviation	114,0 1519.1	236.9 1700.0					3.1 21.6	60.9 229.4	114.0 1319.1	0,4 1.0	107.0 1289.8	250.0 1700.0					15.80659 59.48818	3.10947 21.62711
Minimum Total		514.2 7618476	1200.0	32%	197.1 2688873	196	14572	0.3	0.0 465547	314.2 5866476	0.0	489.8	1200.0	0.3		~~~	40404	0	0.300872
i Çalı		7010470			2000073	190	14072					7152929			2568122	220	13121	120751	
										Wind Ene Wind Ene	rgy Used rgy Availabl	e							
Maximum n	umber of v	wind turbines:	2						٥	Wind Ene	rgy Curtaile	d							
		diesel only-			***************************************				wind hybeid										00 4 6
		aleba any							Single	Maximum									Original
			Diesel	Percent of	Litres of	etarte	Diesel	Adjusted Wind	Turbine Wind	Allowed Wind	Number of	Net	Diesel	Percent of	∐tree of	etarte	Diesel	litres	Wind Speed
Date	Time (hr)	Demand (kW)	Rating (kW)	Rating Used	Diesel Consumed	counter	run time	Speed (m/s)	Power (kW)	Demand	Turbinee	Demand	Reting	Rating	Diesel	counter	run time	saved	6.1 m/s
	(311)	(KVV)	(KVV)	Caec	CONSUMING		(hours)	(rn/s)	(KVV)	(KW)		(KW)	(KW)	Used	Consumed		(hours)		
Average		869.7	1531.7	58%	308.9			6,1	53.1	669.7	1.7	763.4	1393.1	0.5	279.4			27.5688	6.119481
Standard D Maximum	eviation	114.0 1519.1	236.3 1700.0		37.9 484.3			3.1 21.6	60.9 229.4	114.0 1319.1	0.7 2.0	131.6 1277.8	243.6 1700.0						3.10947
Minimum		514.2	1200.0		197.1			0.3	0.0	314.2	0.0	261.1	750.0		154.8				21.62711 0.300872
Total		7618476			2688873	196	14572		465547	5866476		6687381			2447371	236	12144	241503	
									931095		rgy Used rgy Availabl rgy Curtaile								
Maximum n	umber of a	wind lutbinee:	3																
		diesel only-		**********					wind hybrid Single	Maximum							************	·····>	98.4 ft Original
			Direct			-44-		Adjusted	Turbine	Allowed	Number								Wind
Date	Time	Demand	Diesel Rating	Percent of Rating	Litres of Diesel	etarte counter	Diesel run time	Wind Speed	Wind Power	Wind Demand	of Turbines	Net Demand	Diesel Rating	Percent of Rating	Disect	starts counter	Diesel run time	eertii bevee	Speed 6.1 m/s
	(hr)	(kW)	(KW)	Used	Consumed		(houre)	(m/s)	(kW)	(kW)		(kW)	(KW)	Used	Consumed		(hours)		
Average		869.7	1531.7	58%	305.9			6.1	53.1	669.7	2.5	711.4	1355.1	0.5	265.9			41	6.119481
Standard D	eviation	114.0	236.3	8%	37.9			3.1	60.9	114.0	1.1	172.0	247.3	0.1	48.3			46.75209	3.10947
Maximum Minimum		1519.1 514.2	1700.0 1200.0	89% 32%	484.3 197.1			21.6 0.3	229.4 0.0	1319.1 314.2	3.0 0.0	1277.8 201.0	1700.0 750.0	0.8 0.1	421.7 116.1			178.4645	21.62711 0.300872
Total		7618476			2688873	196	14572		465547	5866476		6232205			2329309	282	11618	359564	
										Wind Ener									
											gy Available gy Curtailed								
Maximum n	umber of v	vind turbines:	4																
		diesel only		************	******		····->		wind hybrid Single	Maximum					***************************************				
								Adjusted	Turbine	Allowed	Number								Original Wind
Date	Time	Demand	Diesel Rating	Percent of Hating	Litres of Diesel	etarte counter	Diesel run time	Wind Speed	Wind Power	Wind Demand	of Turbinee	Net Demand	Diesel Rating	Percent of Rating	⊔tree of Diesel	etarte counter	Diesel run tima	litres saved	Speed 6.1 m/s
	(hr)	(kW)	(kW)		Consumed		(hours)	(m/e)	(kW)	(kW)	7 411411100	(KW)	(kW)	Used	Consumed	COUNTRI	(hours)	bavou	0.1111/6
		ana =	454.	***															
Average		869.7	1531.7	58%	306.9			6.1	53.1	669.7	3.3	668.5	1328.3	0.4	254.8			52	6.119481
Standard Do	eviation	114.0	236.3	8%	37.9			3.1	60.9	114.0	1.4	201.7	259.2	0.1					3,10947
Meximum	eviation	1519.1	1700.0	8% 89%	37.9 484.3			21.6	229.4	1319.1	4.0	1277.8	259.2 1700.0	0.1 0.8	55.0 421.7			57.26681 237.9527	
	eviation			8%	37.9	196	14572						259.2		55.0	312	11367	57.26681 237.9527	

1762102 Wind Energy Used 1862189 Wind Energy Available 100087 Wind Energy Curtailed

ECONOMIC ANALYSIS	Site: Turbine: Quantity:	San Clemer 225 kW, Co 1		A, 6.1 m/s avg			
Input Values				<b>Economic Factors</b>			
0 - 1 1 1 (1) (1)	01	7 040 470		December 11 for the official	<u>a variable</u>	<u>n variable</u>	<u>Y(a,n)</u>
System load (kWh/y) Diesel energy (kWh/y)	SL	7,618,476 7,152,929		Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Wind energy (kWh/y)		465,547		Present worth factor of O&M	0.95410277	20	12.07203
Diesel fuel usage, no wind (l/yr)	FL	2,688,873		costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Diesel fuel usage, with wind (I/yr)		2,568,122		Present worth factor of interest	0.001.021.		
Diesel fuel cost (\$/I)	FC	0.264		payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616
Diesel ops cost, variable (\$/kWh)	OV	0.154					
Diesel ops cost, fixed (\$/y)	OF	1,173,245					
Wind ICC (\$)	WC	685,510					
Wind O&M cost (\$/kWh)	WO	0.01					
System life, (yrs)	L	20					
General inflation	İ	2.0%			<u>a variable</u>	<u>n variable</u>	<u>X(a,n)</u>
Fuel inflation	е	2.0%		Capital recovery factor for system			
Discount rate	d	6.9%		income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Interest	b	10.0%		Capital recovery factor for interest	0.0000004	4.0	0.40074500
Term of loan, (yrs)	N	10		payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539
Calculated Values for Both Sys	tems		Diesel	Hybrid System	Hybrid System	n H	ybrid System
			<u>Only</u>	<u>Diesel Part</u>	Wind Part		<u>Total</u>
Capital cost	C = ICC+B	OS	0	·	685,510		685,510
Initial payment on system	Ad	ı	0	_	685,510		685,510
Loan	AI = C - Ad		0	· ·	0		0 0
Annual payment NPV of annual payment	Ap = AI * C Apnpv = AI		0	· · · · · · · · · · · · · · · · · · ·	0		0
Fuel cost per annum	Af = FL * F		709,863	•	0		677,984
NPV of fuel costs	Afnpv = Af		8,995,402	•	0		8,591,439
Overhaul cost per annum	Anipy – Ai	1 771 1	0,333,402		1,000		1,000
NPV of overhaul costs	Aonpv = A	o * PWFO	0		12,672		12.672
O&M costs per annum	Am		2,346,490	•	4,655		2,279,451
NPV of O&M costs	Amnpv = A	m*PWFO	29,734,802		58,994		28,885,284
Total annual costs	At = Ap + Af		3,056,353		5,655		2,958,436
Total system NPV, TNPV	= Ad+sum		38,730,204		757,176		38,174,905
Annual savings	Sv = dsl At	,					97,917
Levelized cost of energy, COE	= TNPV*C	RFI/SL	0.476	0.490	0.152		0.469
Payback period, years							7.00
Internal rate of return, IRR, (x)	[(1+x)^L-1]	/[x*(1+x)^L] -	P =	0.000			13.1%

ECONOMIC ANALYSIS	Site: Turbine: Quantity:	San Clemer 225 kW, Co		A, 5.0 m/s avg			
Input Values	<u> </u>	_		<b>Economic Factors</b>			
0 ( ) ( ) ( ) ( )	01	<b>7</b> 040 4 <b>7</b> 0			<u>a variable</u>	<u>n variable</u>	<u>Y(a,n)</u>
System load (kWh/y) Diesel energy (kWh/y)	SL	7,618,476 7,042,272		Present worth factor of fuel costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Wind energy (kWh/y)		576,204		Present worth factor of O&M	0.95410211	20	12.07203
Diesel fuel usage, no wind (l/yr)	FL	2,688,873		costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Diesel fuel usage, with wind (I/yr)	FL	2,539,421		Present worth factor of interest	0.001.02.1		
Diesel fuel cost (\$/I)	FC	0.264		payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616
Diesel ops cost, variable (\$/kWh)	OV	0.154					
Diesel ops cost, fixed (\$/y)	OF	1,173,245					
Wind ICC (\$)	WC	635,510					
Wind O&M cost (\$/kWh)	WO	0.01					
System life, (yrs)	L	20					
General inflation	i	2.0%			<u>a variable</u>	<u>n variable</u>	<u>X(a,n)</u>
Fuel inflation	e	2.0%		Capital recovery factor for system			
Discount rate	d	6.9%		income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Interest	b	10.0%		Capital recovery factor for interest	0.0000004	10	0.40074500
Term of loan, (yrs)	N	10		payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539
Calculated Values for Both Syst	tems		Diesel	Hybrid System	Hybrid System	n H	ybrid System
			<u>Only</u>	<u>Diesel Part</u>	Wind Part		<u>Total</u>
Capital cost	C = ICC+B	os	0	· ·	1,271,020		1,271,020
Initial payment on system	Ad		0	-	1,271,020		1,271,020
Loan	AI = C - Ad	DED	0	· ·	0		0
Annual payment	Ap = AI * C		0	· ·	0		0
NPV of annual payment	Apnpv = Ap		700.963	•	0		670.407
Fuel cost per annum NPV of fuel costs	AI = FL F Afnpv = Af		709,863 8,995,402	•	0		670,407 8,495,420
Overhaul cost per annum	Anipy – Ai Ao	FVVFF	0,995,402		2,000		2,000
NPV of overhaul costs	Aonpv = Ao	* PW/FO	0		25,344		25,344
O&M costs per annum	Am	) 1 WI O	2,346,490	•	5,762		2,263,517
NPV of O&M costs	Amnpv = A	m*PWFO	29,734,802	· · · · · · · · · · · · · · · · · · ·	73,017		28,683,361
Total annual costs	At = Ap + Af		3,056,353		7,762		2,935,924
Total system NPV, TNPV	= Ad+sum		38,730,204	· · · · · · · · · · · · · · · · · · ·	1,369,381		38,475,145
Annual savings	Sv = dsl At	` '	22,130,201	,	.,500,001		120,429
Levelized cost of energy, COE	= TNPV*C		0.476	0.493	0.223		0.473
Payback period, years	_						10.55
Internal rate of return, IRR, (x)	[(1+x)^L-1]/	[x*(1+x)^L] - I	⊃ =	0.000			7.0%

ECONOMIC ANALYSIS	Site: Turbine: Quantity:	San Clemer 225 kW, Co 2		A, 6.1 m/s avg			
Input Values	<u> </u>	_		<b>Economic Factors</b>			
					<u>a variable</u>	n variable	<u>Y(a,n)</u>
System load (kWh/y)	SL	7,618,476		Present worth factor of fuel			
Diesel energy (kWh/y)		6,687,381		costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Wind energy (kWh/y)		931,095		Present worth factor of O&M			
Diesel fuel usage, no wind (l/yr)	FL	2,688,873		costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Diesel fuel usage, with wind (l/yr)	FL	2,447,371		Present worth factor of interest			
Diesel fuel cost (\$/I)	FC	0.264		payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616
Diesel ops cost, variable (\$/kWh)		0.154					
Diesel ops cost, fixed (\$/y)	OF	1,173,245					
Wind ICC (\$)	WC	635,510					
Wind O&M cost (\$/kWh)	WO	0.01					
System life, (yrs) General inflation	L	20 2.0%			a variable	n variable	V(a n)
Fuel inflation	e	2.0%		Capital recovery factor for system	<u>a variable</u>	<u>n variable</u>	<u>X(a,n)</u>
Discount rate	d	6.9%		income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Interest	b	10.0%		Capital recovery factor for interest	0.9354557	20	0.09300034
Term of loan, (yrs)	N	10.0%		payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539
Calculated Values for Both Syst	tems		Diesel	Hybrid System	Hybrid System	Hy	/brid System
			<u>Only</u>	<u>Diesel Part</u>	Wind Part		<u>Total</u>
Capital cost	C = ICC+B	os	0		1,271,020		1,271,020
Initial payment on system	Ad		0		1,271,020		1,271,020
Loan	AI = C - Ad		0	<u> </u>	0		0
Annual payment	Ap = AI * C		0	· ·	0		0
NPV of annual payment	Apnpv = Ap		700.000	•	0		0
Fuel cost per annum	Af = FL * F		709,863		0		646,106
NPV of fuel costs	Afnpv = Af	PVVFF	8,995,402		2 000		8,187,475
Overhaul cost per annum NPV of overhaul costs	Ao Aonpv = Ao	2 * DWEO	0		2,000 25,344		2,000 25,344
O&M costs per annum	Aoripv = Ao	5 PWFO	2,346,490	· ·	25,3 <del>44</del> 9,311		25,344 2,212,413
NPV of O&M costs	Amnpv = A	m*D\//EO	2,340,490	· · · · · · · · · · · · · · · · · · ·	117,989		28,035,766
Total annual costs	At = Ap + Af		3,056,353		11,311		2,860,519
Total system NPV, TNPV	= Ad+sum		38,730,204	· · · · · · · · · · · · · · · · · · ·	1,414,353		37,519,605
Annual savings	Sv = dsl At	` '	30,7 00,204	00,100,202	1, 117,000		195,834
Levelized cost of energy, COE	= TNPV*C		0.476	0.506	0.142		0.461
Payback period, years	7 0	<i></i>	2.110	5.555	5.112		6.49
Internal rate of return, IRR, (x)	[(1+x)^L-1]/	/[x*(1+x)^L] - I	P =	0.000			14.4%

ECONOMIC ANALYSIS	Site: Turbine: Quantity:	San Clemer 225 kW, Co 2		A, 7.2 m/s avg			
Input Values				Economic Factors			
					<u>a variable</u>	<u>n variable</u>	<u>Y(a,n)</u>
System load (kWh/y)	SL	7,618,476		Present worth factor of fuel			
Diesel energy (kWh/y)		6,323,127		costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Wind energy (kWh/y)		1,295,349		Present worth factor of O&M			
Diesel fuel usage, no wind (l/yr)	FL	2,688,873		costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Diesel fuel usage, with wind (I/yr)		2,352,892		Present worth factor of interest			
Diesel fuel cost (\$/I)	FC	0.264		payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616
Diesel ops cost, variable (\$/kWh)		0.154					
Diesel ops cost, fixed (\$/y)	OF	1,173,245					
Wind ICC (\$)	WC	635,510					
Wind O&M cost (\$/kWh)	WO	0.01					
System life, (yrs)	L	20					
General inflation	i	2.0%			<u>a variable</u>	<u>n variable</u>	<u>X(a,n)</u>
Fuel inflation	е	2.0%		Capital recovery factor for system			
Discount rate	d	6.9%		income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Interest	b	10.0%		Capital recovery factor for interest			
Term of loan, (yrs)	N	10		payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539
Calculated Values for Both Sys	<u>.</u>		Diesel <u>Only</u>	Hybrid System <u>Diesel Part</u>	Hybrid System <u>Wind Part</u>	n H	ybrid System <u>Total</u>
Capital cost	C = ICC+B	OS	0	•	1,271,020		1,271,020
Initial payment on system	Ad		0		1,271,020		1,271,020
Loan	AI = C - Ad		0	•	0		0
Annual payment	Ap = AI * C		0	•	0		0
NPV of annual payment	Apnpv = A		0	•	0		0
Fuel cost per annum	Af = FL * F		709,863		0		621,164
NPV of fuel costs	Afnpv = Af	* PWFF	8,995,402		0		7,871,405
Overhaul cost per annum	Ao		0	•	2,000		2,000
NPV of overhaul costs	Aonpv = A	o * PWFO	0	•	25,344		25,344
O&M costs per annum	Am		2,346,490	·	12,953		2,159,960
NPV of O&M costs	Amnpv = A		29,734,802		164,147		27,371,085
Total annual costs	At = Ap + At		3,056,353	·	14,953		2,783,124
Total system NPV, TNPV	= Ad+sum	` '	38,730,204	35,078,343	1,460,511		36,538,854
Annual savings	Sv = dsl At						273,229
Levelized cost of energy, COE	= TNPV*C	RFI/SL	0.476	0.520	0.106		0.449
Payback period, years							4.65
Internal rate of return, IRR, (x)	[(1+x)^L-1]	/[x*(1+x)^L] - I	P =	0.000			21.0%

ECONOMIC ANALYSIS	Site: Turbine: Quantity:	San Clemer 225 kW, Co 3		A, 6.1 m/s avg			
Input Values	<u></u>			<b>Economic Factors</b>			
					<u>a variable</u>	n variable	<u>Y(a,n)</u>
System load (kWh/y)	SL	7,618,476		Present worth factor of fuel			
Diesel energy (kWh/y)		6,232,205		costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Wind energy (kWh/y)		1,386,271		Present worth factor of O&M			
Diesel fuel usage, no wind (l/yr)	FL	2,688,873		costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
Diesel fuel usage, with wind (I/yr)	FL	2,329,309		Present worth factor of interest			
Diesel fuel cost (\$/I)	FC	0.264		payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616
Diesel ops cost, variable (\$/kWh)		0.154					
Diesel ops cost, fixed (\$/y)	OF	1,173,245					
Wind ICC (\$)	WC	610,510					
Wind O&M cost (\$/kWh)	WO	0.01					
System life, (yrs)	L	20					
General inflation	I	2.0%			<u>a variable</u>	<u>n variable</u>	<u>X(a,n)</u>
Fuel inflation	e	2.0%		Capital recovery factor for system	0.0054505		0.000000=4
Discount rate	d	6.9%		income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Interest	b	10.0% 10		Capital recovery factor for interest	0.00000004	40	0.16274539
Term of loan, (yrs)	N	10		payments, CRFP, a=1/(1+b)	0.90909091	10	0.10274559
Calculated Values for Both Syst	tems		Diesel	Hybrid System	Hybrid System	ı Hv	brid System
			Only	Diesel Part	Wind Part	•	Total
Capital cost	C = ICC+B	os	0		1,831,530		1,831,530
Initial payment on system	Ad		0	0	1,831,530		1,831,530
Loan	AI = C - Ad		0	0	0		0
Annual payment	Ap = AI * C	RFP	0	0	0		0
NPV of annual payment	Apnpv = Ap	o*PWFP	0	0	0		0
Fuel cost per annum	Af = FL * F		709,863	The state of the s	0		614,938
NPV of fuel costs	Afnpv = Af	* PWFF	8,995,402	7,792,510	0		7,792,510
Overhaul cost per annum	Ao		0		3,000		3,000
NPV of overhaul costs	Aonpv = A	o * PWFO	0	<u> </u>	38,016		38,016
O&M costs per annum	Am		2,346,490	t t	13,863		2,146,867
NPV of O&M costs	Amnpv = A		29,734,802		175,669		27,205,172
Total annual costs	At = Ap + Af		3,056,353		16,863		2,764,805
Total system NPV, TNPV	= Ad+sum		38,730,204	34,822,014	2,045,215		36,867,229
Annual savings	Sv = dsl At						291,548
Levelized cost of energy, COE	= TNPV*C	RFI/SL	0.476	0.523	0.138		0.453
Payback period, years Internal rate of return, IRR, (x)	[(1+x)^L-1]	/[x*(1+x)^L] - I	P =	0.000			6.28 14.9%
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ECONOMIC ANALYSIS	Site: Turbine: Quantity:	San Clemer 225 kW, Co 4		A, 6.1 m/s avg				
Input Values				<b>Economic Factors</b>				
						<u>a variable</u>	n variable	<u>Y(a,n)</u>
System load (kWh/y)	SL	7,618,476		Present worth factor of				
Diesel energy (kWh/y)		5,856,374		costs, PWFF, a=(1+e)		0.95416	20	12.67203
Wind energy (kWh/y)		1,762,102		Present worth factor of				
Diesel fuel usage, no wind (l/yr)	FL	2,688,873		costs, PWFO, a=(1+i)/	, ,	0.95416	20	12.67203
Diesel fuel usage, with wind (l/yr)		2,231,828		Present worth factor of				
Diesel fuel cost (\$/I)	FC	0.264		payments, PWFP, a=1	I/(1+b)	0.93545	10	7.05616
Diesel ops cost, variable (\$/kWh)		0.154						
Diesel ops cost, fixed (\$/y)	OF	1,173,245						
Wind ICC (\$)	WC	585,510						
Wind O&M cost (\$/kWh)	WO	0.01						
System life, (yrs)	L	20				a variabla	ما ما منسمی در س	V(a a)
General inflation	1	2.0%		Canital reservements atom	. fo., o., o.	<u>a variable</u>	<u>n variable</u>	<u>X(a,n)</u>
Fuel inflation	e d	2.0% 6.9%		Capital recovery factor income, CRFI, a=1/(1+		0.93545	20	0.09366
Discount rate Interest	b	10.0%		Capital recovery factor		0.93545	20	0.09300
Term of loan, (yrs)	N	10.0 %		payments, CRFP, a=1		0.90909	10	0.16275
remi or loan, (yrs)	14	10		payments, ord 1, a-1	7(110)	0.30303	10	0.10273
Calculated Values for Both Sys	tems		Diesel	Hybrid Sys	tem	Hybrid System	ı Hv	brid System
			Only	Diesel Pa		Wind Part	,	Total
Capital cost	C = ICC+B	SOS	0		0	2,342,040		2,342,040
Initial payment on system	Ad		0		0	2,342,040		2,342,040
Loan	AI = C - Ac	i	0		0	0		0
Annual payment	Ap = AI * C	RFP	0		0	0		0
NPV of annual payment	Apnpv = A	p*PWFP	0		0	0		0
Fuel cost per annum	Af = FL * F	:C	709,863	589,2	.03	0		589,203
NPV of fuel costs	Afnpv = Af	* PWFF	8,995,402	7,466,3	95	0		7,466,395
Overhaul cost per annum	Ao		0		0	4,000		4,000
NPV of overhaul costs	Aonpv = A	o * PWFO	0		0	50,688		50,688
O&M costs per annum	Am		2,346,490			17,621		2,092,748
NPV of O&M costs	Amnpv = A		29,734,802	·		223,294		26,519,366
Total annual costs	At = Ap + A		3,056,353			21,621		2,685,950
Total system NPV, TNPV	= Ad+sum		38,730,204	33,762,4	67	2,616,022		36,378,490
Annual savings	Sv = dsl At							370,403
Levelized cost of energy, COE	= TNPV*C		0.476	0.5	40	0.139		0.447
Payback period, years	P = C / Sv		<b>5</b>	0.000				6.32
Internal rate of return, IRR, (x)	[(1+x)^L-1]	/[x*(1+x)^L] -	Ρ=	0.000				14.8%

ECONOMIC ANALYSIS	Site: Turbine: Quantity:	Fictitious M 225 kW, Co 2		e, Non-Naval, 6.1 m/s avg			
Input Values				<b>Economic Factors</b>			
					<u>a variable</u>	<u>n variable</u>	<u>Y(a,n)</u>
System load (kWh/y)	SL	7,618,476		Present worth factor of fuel	0.05440077	00	40.07000
Diesel energy (kWh/y)		6,687,381		costs, PWFF, a=(1+e)/(1+d)	0.95416277	20	12.67203
Wind energy (kWh/y) Diesel fuel usage, no wind (l/yr)		931,095 2,688,873		Present worth factor of O&M costs, PWFO, a=(1+i)/(1+d)	0.95416277	20	12.67203
	FL			Present worth factor of interest	0.95416277	20	12.07203
Diesel fuel usage, with wind (l/yr) Diesel fuel cost (\$/I)	FC FC	2,447,371 0.264		payments, PWFP, a=1/(1+b)	0.9354537	10	7.05616
Diesel ops cost, variable (\$/kWh)		0.264		payments, PWFP, a=1/(1+b)	0.9354537	10	7.00010
Diesel ops cost, fixed (\$/y)	OF	1,173,245					
Wind ICC (\$)	WC	354,600					
Wind O&M cost (\$/kWh)	WO	0.01					
System life, (yrs)	L	20					
General inflation	i	2.0%			a variable	n variable	X(a,n)
Fuel inflation	e	2.0%		Capital recovery factor for system	<u>a variable</u>	ii vanabie	$\Lambda(a,\Pi)$
Discount rate	d	6.9%		income, CRFI, a=1/(1+d)	0.9354537	20	0.09366054
Interest	b	10.0%		Capital recovery factor for interest	0.5554551	20	0.03300034
Term of loan, (yrs)	N	10.070		payments, CRFP, a=1/(1+b)	0.90909091	10	0.16274539
Calculated Values for Both Sys	<u>tems</u>		Diesel	Hybrid System	Hybrid System	n H <u>i</u>	ybrid System
Carital and	C = 100 + D	00	<u>Only</u>	<u>Diesel Part</u>	Wind Part		Total
Capital cost	C = ICC+B	08	0	•	709,200		709,200
Initial payment on system	Ad $AI = C - Ad$		0	•	709,200		709,200
Loan	Ap = C - Ad Ap = Al * C		0	•	0		0
Annual payment NPV of annual payment	•		0	·	0		0
Fuel cost per annum	Apnpv = Apart Af = FL * F		709,863	•	0		646,106
NPV of fuel costs	AI - FL - F Afnpv = Af	_	8,995,402	•	0		8,187,475
Overhaul cost per annum	Ampv – Ar Ao	FVVFF	0,995,402		2,000		2,000
NPV of overhaul costs	Aonpv = A	o * D\\/E∩	0		25,344		25,344
O&M costs per annum	Am Am	O FWIO	2,346,490	<u> </u>	9,311		2,212,413
NPV of O&M costs	Amnpv = A	m*D\\/E0	2,340,490		117,989		28,035,766
Total annual costs	At = Ap + Af		3,056,353		11,311		2,860,519
Total system NPV, TNPV	= Ad+sum		38,730,204		852,533		36,957,785
Annual savings	Sv = dsl At		30,730,204	30,103,232	032,333		195,834
Levelized cost of energy, COE	= TNPV*C		0.476	0.506	0.086		0.454
Payback period, years	- INFV C	/IXI I/OL	0.470	0.500	0.000		3.62
Internal rate of return, IRR, (x)	[(1+x)^L-1]	/[x*(1+x)^L] -	P =	0.000			27.4%

